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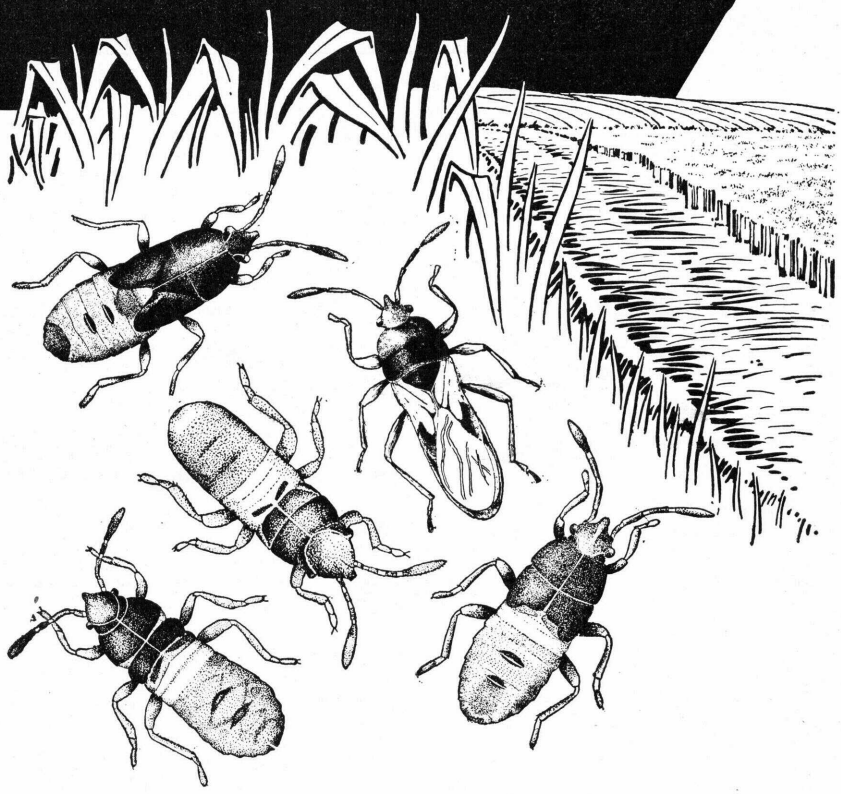
How to fight the CHINCH BUG



Farmers'
Bulletin
No. 1780

U. S. DEPARTMENT OF AGRICULTURE

THE CHINCH BUG is a destructive pest of grasses, corn, and small grains throughout the central and eastern United States.

Chinch bugs can be controlled by growing immune or resistant crops or modifying farm practices to prevent infestations. Barriers are effective also, for they kill the bugs while they are migrating from small grains to corn or other susceptible crops. As yet, spraying and dusting are too expensive to be recommended for general use.

Some of the information in this bulletin was taken from Circulars 431 and 590 of the Illinois Agricultural Experiment Station, and from Circular 213 of the Iowa Agricultural Extension Service.

Washington, D. C.

Issued August 1937
Revised September 1951

HOW TO FIGHT THE CHINCH BUG

By C. M. PACKARD,[1] PHILIP LUGINBILL,[1] SR., and CURTIS BENTON, *entomologists, Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration*

CONTENTS

THE CHINCH BUG is one of the most destructive insects attacking grain and grass crops in the United States. It has reached its greatest abundance in the regions drained by the Mississippi, Ohio, and Missouri Rivers.

Grain growers have sought methods of controlling this insect since its first general outbreak, about 1785. Since then there have been numerous chinch-bug outbreaks, some of them covering only parts of one or two States, but others extending over a much wider area. The chinch bug's habit of feeding on the extensively grown grains and grasses, its rapid rate of reproduction, and its frequent occurrence in enormous numbers make it an extremely difficult pest to control.

DESCRIPTION OF THE CHINCH BUG

The full-grown chinch bug [2] is black with white markings, about ⅙ inch long (front cover and fig. 4, *G*). Both long-winged and short-winged forms are found, but the long-winged form prevails throughout the Central States. It is capable of flying long distances, probably as far as 10 miles in a single flight when the wind is favorable. The short-winged individuals are unable to fly. In the East and North a similar species, known as the hairy chinch bug,[3] also is found, especially in lawns and grassy areas. Short-winged individuals are usually more prevalent in that species.

[1] Retired September 30, 1950.
[2] *Blissus leucopterus* (Say).
[3] *Blissus hirtus* Montd.

SEASONAL HISTORY

There are at least two generations of the chinch bug each year throughout its entire range in this country. A third generation usually develops in the extreme South, and occasionally a partial third generation as far north as Iowa.

FIGURE 1.—Bunchy perennial grasses are preferred by chinch bugs for winter quarters.

OVERWINTERING

Chinch bugs overwinter in the adult stage, hidden in shelters that afford them good protection from the weather. They hide deep down in the tufts of perennial grasses (fig. 1), some of which are known locally as bunchgrass, bluestem, prairie grass, broomgrass, swale grass,

beardgrass, and by several other names. The bugs may also hibernate in clump-forming grasses, such as timothy, purpletop, orchard grass, dropseed, and sedges. Many bugs pass the winter under leaves and litter in the borders of woodlands and under hedges, especially when they contain some grass (fig. 2). From November to April the hibernating chinch bugs are most likely to be found on warm southern and western exposures where the sun shone during the afternoons of the preceding September and October when they were seeking winter quarters.

FIGURE 2.—Tufts of grass among woodland leaves are also favored places for hibernation.

Chinch bugs may sometimes be found under large leaves of mullein or other weeds that form rosettes at the surface of the ground, in shocks of corn or standing cornstalks, and in sorghum stubble; also under bark of dead trees and fence posts, under boards and logs, or under loose boards and shingles of houses, in sheds and outbuildings, and in various other shelters. The number that pass the winter in all such places is small, however, and many of them die.

THE SPRING FLIGHT

The spring flights of overwintering bugs take place some time between February or March and the last part of May, usually after 1 or 2 sunny days when for several hours the temperature remains at 70° F. or more. In most years the flight is gradual, but sometimes nearly all the chinch bugs in a locality leave their winter shelters during 2 or 3 days of favorable weather. They generally settle in fields of small grain, especially in the thinner or poorer parts of such fields—in wheat if that is the predominating small-grain crop, but often more abundantly in rye or barley if they are available. When oats have been planted early and cool weather has delayed the flight until the

oats have made a good growth, many of the bugs may also settle in this crop. In such years a few may even fly direct to young corn.

In the fields of small grain the bugs spend a few days feeding before they begin egg laying. Ordinarily they cause little injury to the small grains, but in years of drought and heavy infestation they may seriously injure or even kill the plants in heavily infested areas of the fields. When these grains dry up or the growth becomes thick and rank, the bugs move to other fields. Occasionally oats and corn become seriously infested in this way.

After the old bugs have practically finished laying eggs, they may fly to young corn. The sudden appearance of these spent adults in the cornfields is alarming, but needlessly so, since they soon die without doing much feeding or egg laying on the corn. The real danger at this time is from the young bugs left in the small grains.

DEVELOPMENT AND MIGRATION OF FIRST GENERATION

The females lay their eggs behind the lower leaf sheaths of the grain plants or in the ground nearby. In dry years when the ground is cracked, eggs may be laid on the roots. The eggs ordinarily hatch in 1 to 2 weeks. By wheat harvesttime practically all the old bugs are dead, and young bugs of the new generation are present in nearly all stages of growth, although still unable to fly.

As the small grains ripen or dry up, the young bugs begin traveling on foot to find succulent food. They do this mainly in the afternoons of sunny days, although in cloudy weather there may be some movement throughout the day. They move into adjacent fields of young corn, sorghum, or other plants of the grass family, where they resume feeding and complete their growth to the winged stage. It is during this migration that barrier traps (see p. 12) are effective. In areas as far south as Oklahoma, where the first generation develops earlier than in more northern areas, most of the bugs may reach the winged stage and fly into corn and sorghum fields, thus rendering barrier traps useless.

THE SUMMER FLIGHT AND DEVELOPMENT OF LATER GENERATIONS

In the more northern areas from 2 weeks to a month after the small grain is harvested, the bugs make a second flight to seek plants on which to feed and deposit eggs. It is during this flight that the bugs spread throughout the corn and sorghum fields, especially to the parts where the growth is thin or poor. As the summer advances, the adults of the first generation complete their egg laying and gradually die off. The second generation, which hatches from these eggs, feeds mainly on corn, sorghum, foxtail, timothy, Sudan grass, and other grasses which may be in succulent condition during the summer. This generation reaches the full-grown winged stage late in the summer or early in the fall. In parts of the country where activity begins earlier in the spring and continues later in the fall, a third generation usually develops.

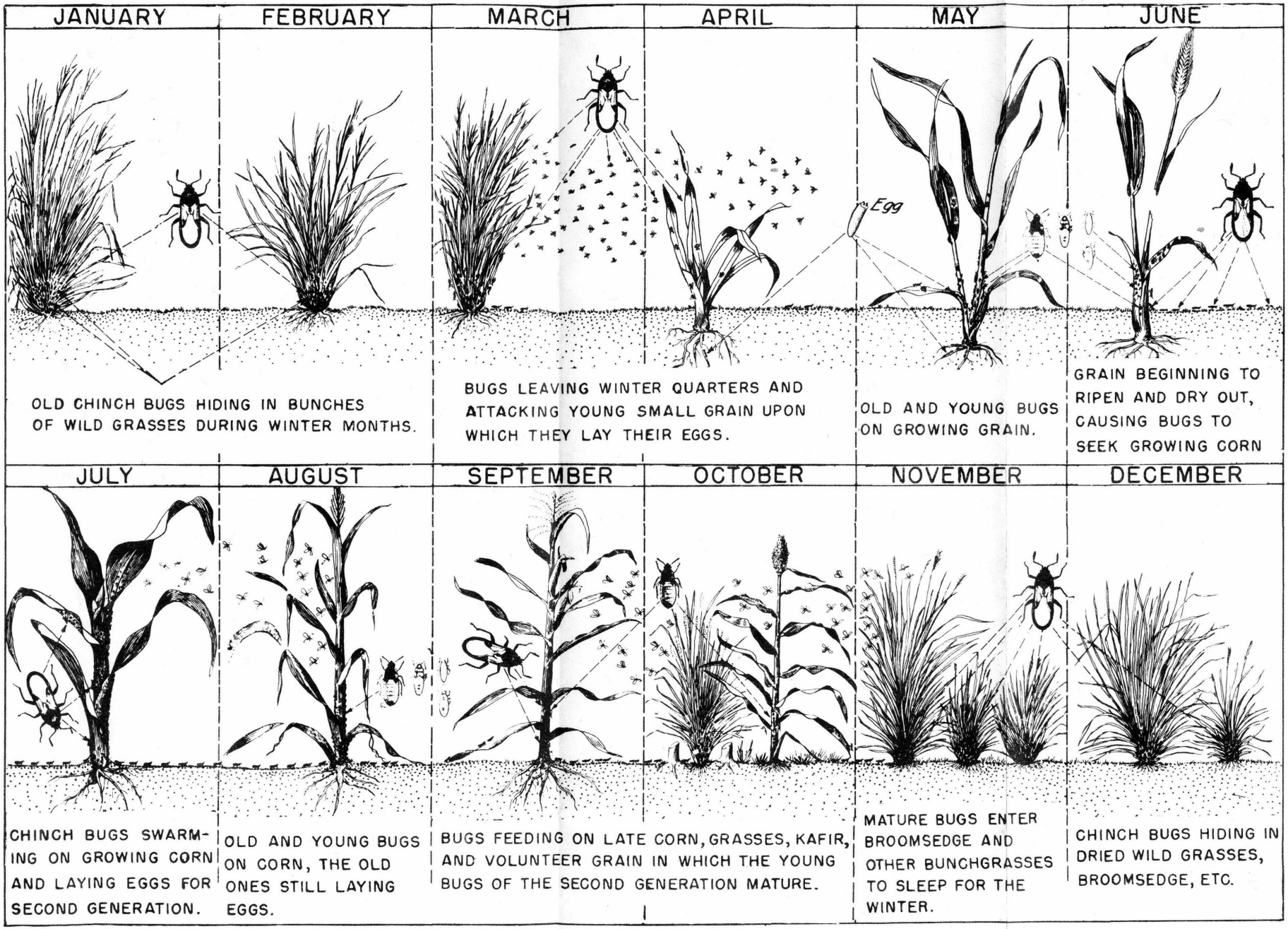


FIGURE 3.—Seasonal history of the chinch bug in the Central States.

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THE FALL FLIGHT TO WINTER QUARTERS

The third, and last, flight occurs in the fall, when the second- and third-generation adults leave their food plants and seek hibernation quarters. Much of this flight seems to be rather gradual, beginning late in August and continuing through October and, in the South, even into November. However, heavy flights often take place toward the end of this season, particularly on very warm, sunny days following a period of frosty weather. The bugs seek winter quarters only on days when the sun is shining and while the temperature is at least 70° F.

In these quarters the chinch bugs become sluggish when the temperature is low, and inactive when it is below freezing, but during periods of comparatively high temperature in the winter they may move about to a limited extent. Although they may take water, they apparently do not feed from the time they seek their winter quarters in the fall until they leave them in the spring. Some mating may occur before the spring flight. The seasonal history of this insect is illustrated in figure 3.

LIFE STAGES

The female chinch bug lays several hundred eggs at the rate of 15 or 20 a day. The eggs, which are about $\frac{1}{32}$ inch long (fig. 4, *A*), hatch in 7 to 45 days, depending mainly upon the temperature. A very young bug (fig. 4, *B*) is about half the size of a pin head, and bright red with a transverse band of white. This bug sheds its skin five times, and with each change it becomes darker until, in the last stage before acquiring wings, it is grayish black with a conspicuous white spot on the back between the wing pads. In all immature stages (fig. 4, *B* to *F*) the insect is wingless and has to depend entirely upon its legs for locomotion. In the sixth, or adult, stage the insect has wings, is about $\frac{1}{6}$ inch long, and is black with white markings (fig. 4, *G*).

PLANTS ATTACKED

So far as is known, the chinch bug feeds only on plants belonging to the grass family. Barley, spring wheat, winter wheat, rye, and oats seem to be preferred in about the order named, although from year to year the order may vary with the condition of the grains at the time of the spring flight. During April, May, and June, after the spring flight, probably 90 percent of the bugs are in the small grains. Where the acreage of small grains is low, the bugs may be found on timothy, junegrass, and several other wild grasses that appear during these months. Occasionally a few bugs occur on bluegrass, but apparently this grass is not succulent enough to be attractive, as the chinch bug must have a food plant with a considerable flow of sap, as well as with stems that it can pierce readily with its beak.

Throughout the corn-growing areas the second generation of chinch bugs feeds mainly on corn and sorghum (fig. 5), but also on other grains and grasses that are succulent late in the summer, including timothy, barnyard grass, tickle grass, crabgrass, foxtail, bentgrass, and other lawn grasses.

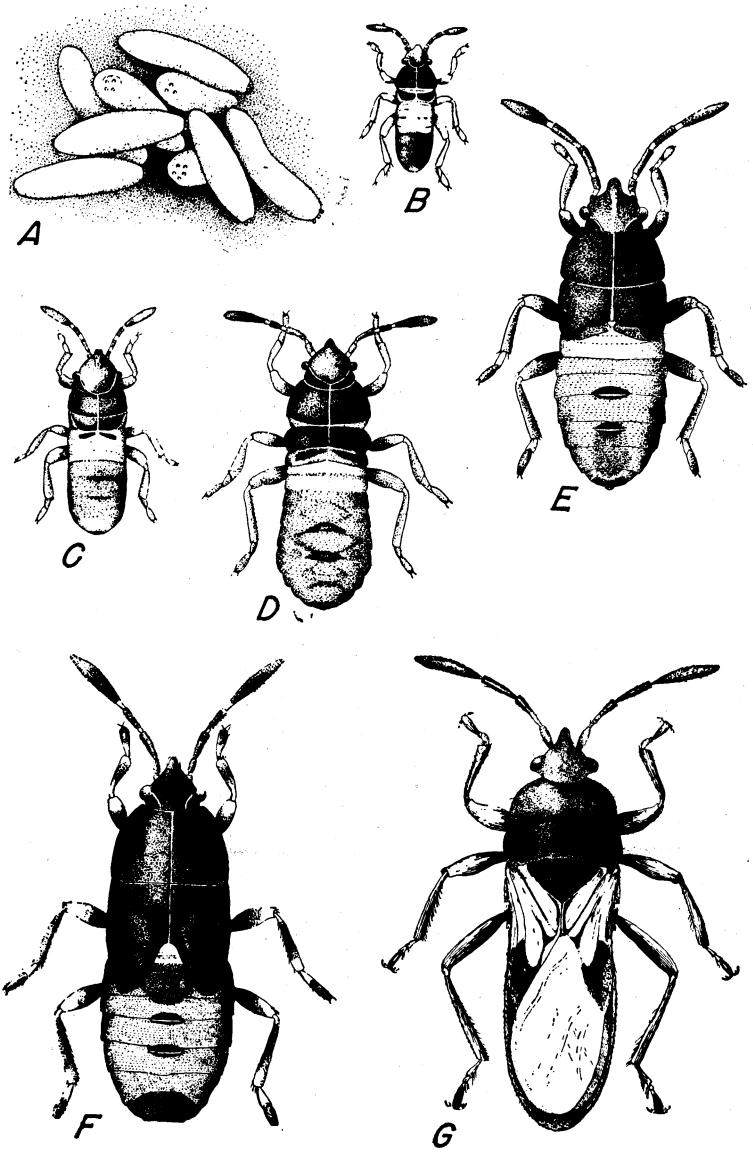

FIGURE 4.—Chinch bugs: *A*, Eggs; *B–F*, the five immature stages; *G*, the winged adult. All greatly enlarged.

PLANTS NOT INJURED

Fortunately the chinch bug does not develop on any of the legumes, such as clovers, alfalfa, vetch, lespedeza, soybeans, cowpeas, field peas, peanuts, and velvetbeans. Other common crops on which it does not develop are sunflower, flax, rape, stock beet, buckwheat, pumpkin, squash, and all the truck or garden crops except sweet corn. When the bugs are extremely abundant and their normal food plants become scarce, they sometimes try to feed on these crops. They cannot feed successfully on these plants, however, and only rarely do they attempt to do so in numbers large enough to cause injury. The substitution of legumes and other immune crops for small grains and corn offers one of the most important and valuable ways of avoiding or overcoming trouble due to chinch bugs.

FIGURE 5.—Corn damaged by invasion of chinch bugs from adjacent small grain. This damage could have been prevented by timely use of a good barrier or by not planting corn and small grain in adjoining fields.

IMPORTANCE OF WEATHER ON CHINCH BUG ABUNDANCE

The weather is the chief factor governing the abundance of chinch bugs. They are most susceptible to weather conditions while they are hatching. Frequent heavy, driving rains at this time beat the young bugs into the mud, from which they are unable to escape. Such storms also cover the eggs with mud and prevent them from hatching, and keep the females from laying their full number of eggs. As a result the bugs may be of little importance as farm pests for several seasons.

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Frequent rains or periods of warm, damp weather also favor the development of the chinch bugs' worst natural enemy, the white fungus disease.

Chinch bugs are less able to survive an open, wet winter than a cold one with heavy snow cover. Many bugs are also killed by sudden changes in temperature, extremely low temperatures while there is little snow cover, or the formation of ice in their hibernation quarters due to a sudden freeze following a thaw or rain. In the Middle West, however, less than 12 percent of the bugs die in a normal winter.

All chinch bug outbreaks have begun during periods of normal or less-than-normal rainfall. Usually these outbreaks have been ended only after several years in which the weather and crop conditions were detrimental to the insect. One of the most persistent outbreaks originated in 1910, in Illinois, Missouri, and Kansas; except in 1915, when an extremely wet summer greatly reduced their numbers, losses were heavy every year until 1925. Again in 1930 lack of rainfall during the breeding season allowed increases in chinch bug abundance which culminated in 1934 in the most severe and widespread outbreak ever known. Populations were greatly reduced in 1935, locally by winter mortality but mainly by the widespread cold, rainy weather in May and June. The spring flight was delayed, egg laying reduced, and many bugs of the first generation were destroyed as they hatched. Unfavorable weather during the spring months prevailed from 1938 to 1950; as a consequence, no general outbreak occurred during this period and chinch bug damage to crops was confined to localized areas.

NATURAL ENEMIES

Probably the most destructive natural enemy of the chinch bug is the disease caused by the white fungus.[4] It is generally present in the fields throughout the country, but its effectiveness is dependent on the weather. Since it has been proved that the spores of this fungus are present wherever the bugs are common, its artificial dissemination as a control measure is needless.

Next in importance is the tiny parasitic insect *Eumicrosoma beneficа* Gahan. This little wasp lays an egg in the chinch bug egg. The maggot hatching from the wasp egg develops within and consumes the contents of the chinch bug egg. When the maggot becomes full-grown it changes to the adult wasp, which emerges from the empty egg. This beneficial insect is so small that probably it is never seen by farmers. When held in the palm of the hand, it appears to be merely a dark speck, and only microscopic examination reveals it as an insect; yet records show that it has parasitized from 30 to 50 percent of the chinch bug eggs in certain localities. Such a high percentage of parasitization is unusual, however. It is known to occur in most of the States of the Middle West and in one Eastern State, but has not been taken in the far West.

Several other fungus diseases and insects also attack the chinch bug. A number of birds, including the bobwhite, the red-winged blackbird, the catbird, the brown thrasher, and the meadowlark, are also known

[4] *Beauveria globulifera.*

to feed on it. More than 200 chinch bugs were found in the stomach of a single brown thrasher and more than 100 each in the stomachs of a bobwhite and a meadowlark. Many other birds have eaten from 5 to 50 chinch bugs at a single meal. However, none of the birds appear to be important factors in its control.

CONTROL MEASURES

The duration of chinch bug outbreaks is so uncertain that it is never safe for the grain grower to depend upon natural agencies to curb them. Various methods of control, including spraying and dusting, have been tried, but only three measures have proved generally practical—(1) growing immune or resistant crops, (2) modifying farm practices to prevent infestation, and (3) using barrier traps to kill the bugs while they are migrating from small grains to corn or other susceptible crops.

GROWING IMMUNE OR RESISTANT CROPS

Since the first-generation bugs feed mainly on small grains and those of the second generation on corn and sorghum, a good way to hold this insect in check is to make its food supply as scarce as possible. This can be done by reducing the acreage of small grains where corn and sorghum are the leading crops, or of corn and sorghum where small grains predominate, and planting legumes or other immune crops in their place. In this way one or the other of the two main annual generations of bugs will be severely handicapped.

For a farm well adapted to corn production a rotation of corn, soybeans, corn, oats, or wheat and clover will result in as little loss as any that includes both small grain and corn. With this rotation corn would occupy about two-fifths and the other crops each about one-fifth of the cropped land each year. In areas better suited to the production of small grains, a rotation may be used in which wheat or oats, clover, corn, and soybeans each occupies about one-fourth of the cropped land each year. The most suitable rotation for any particular farm where the chinch bug is a problem can best be ascertained from your county agent or State agricultural experiment station.

Since legumes are practically immune from chinch bug injury, they should be grown not only by themselves but also, where practical, among small grains and corn. Clover, alfalfa, or vetch grown among small grains and soybeans or cowpeas among corn often produce shade and dampness around the grain plants so that the bugs avoid them.

Soybeans and cowpeas afford the corn considerable protection. In the presence of chinch bug infestations corn grown with soybeans or cowpeas has yielded from 2 to 15 more bushels per acre than when grown without these legumes. The degree of benefit depends on the number of chinch bugs present, the fertility of the soil, and the weather. Even under extremely dry conditions, soybeans planted at the rate of three beans per hill of corn have yielded from 10 to 12 bushels per acre when all the corn was destroyed. Under nearly all conditions the legumes should afford good pasturage for hogs, sheep, and cattle, and give at least a partial crop on the land.

Although certain strains or varieties of corn and sorghum need protection from the first-generation bugs, they are decidedly resistant to the second-generation bugs. However, some types of sorghums—particularly the milos, Honey sorgo, and Texas milo—are so susceptible that they are not ordinarily grown where chinch bugs are prevalent. Several open-pollinated varieties of corn grown in southern Illinois have produced fair yields under heavy infestations, although these varieties were not highly resistant to the chinch bug.

In Illinois, Kansas, and Oklahoma, in recent years, much progress has been made in the development of hybrid corns and sorghums distinctly resistant to second-generation chinch bugs. The Oklahoma Agricultural Experiment Station has released two varieties of sorghum—Kaferita C. I. 811, a kafir × feterita cross considered the most resistant variety grown in Oklahoma, and a Honey selection which is much more resistant than the standard Honey variety. These results indicate the possibility of finding resistant strains adapted to other regions as well. The best of the corn hybrids are much more resistant than the open-pollinated varieties. When seed of resistant corn hybrids is available, it should be used instead of seed of susceptible strains.

For information concerning resistant strains of corn or sorghum for your locality, consult your county agent or State agricultural experiment station.

MODIFYING FARM PRACTICES TO REDUCE INFESTATION

When it is not practical to eliminate, or even to reduce materially, the acreage of small grains on farms where the chinch bug is a problem, other measures must be taken to lessen infestations in these grains.

Infestations may be reduced by selecting the proper grain to plant, where a choice can be made. Since chinch bugs will usually feed and breed abundantly in any of the small grains, none of them can be depended upon for use as a trap crop in which the bugs may be concentrated and destroyed. Spring barley should not be planted when there is a prospect of chinch bug abundance. Where feasible, the acreages of wheat and rye should be reduced and oats planted in their place.

In the more southern areas winter barley sown early in the fall produces in the spring a thick growth that is less attractive to chinch bugs than spring-sown barley. Furthermore, the winter barley matures so early that it can be harvested before the first-generation bugs have injured it materially. The barley can be used a while for spring pasture, or harvested for grain, and the ground then plowed for replanting to soybeans the same season. In this way the bugs are destroyed before they are able to migrate to other crops. In some of these areas the advantages to be gained through sowing winter barley early in the fall for pasture appear to outweigh the objection to this crop on account of its attractiveness to chinch bugs.

The stimulation of a thick, vigorous growth of grain also lessens infestations. Chinch bugs seldom congregate or breed in heavy stands of any small grain. Hence anything that can be done to produce this condition, such as thorough tillage, ample fertilization, and timely seeding, helps to reduce injury from the bugs. Even winter wheat can be planted with fair assurance that chinch bugs will not breed in it abundantly. A dense growth of clover in small grain helps to bring about a damp, shady condition that is also unfavorable to the bugs.

In dry seasons when infestations are severe, ruined fields of small grain can sometimes be disked or plowed to destroy the bugs, and replanted with soybeans or some other immune crop. Before such a field is plowed, a dust barrier (see page 18) should be prepared to prevent the bugs from migrating into adjacent grain or grass fields. Immediately after it has been plowed, the entire field should be thoroughly cultivated to destroy all green growth and to produce a good dust mulch. By these means the bugs usually can be starved or otherwise killed. Corn or a quick-growing grass crop can be planted after such treatment, provided the dust mulch has been maintained until all eggs have hatched and all the bugs in the field have been killed.

Where migrating bugs have ruined young corn, the ground can often be disked and replanted to soybeans, so that a worthwhile crop is obtained from the land even though the original crop of corn is lost. Early planting will partly prevent injury to corn and sorghums. Where the European corn borer is present, however, early planting of these crops is inadvisable.

Still another way of reducing chinch bug damage is to avoid adjacent plantings of small grain and corn. Where this is not possible, a chemical barrier should be run between the plantings if necessary. Just before harvesttime close watch should be kept for chinch bugs in the small grains to determine whether migration to corn may be expected. Neighbors can often cooperate by planting corn in adjoining fields or otherwise avoiding the growing of small grain and corn adjacent to each other.

In the more western areas, where the native bunchgrasses form the principal shelter, burning over these grasses while the bugs are in them—some time between November 1 and March 15—may help to reduce their numbers. On the other hand, in areas where many of the bugs hibernate in other types of shelter, winter burning is not a practical or effective method of control. Woodlands should never be burned over, because the harm to young growth and wildlife refuges will more than offset the benefit. The natural bird shelters in unwooded areas also should be left unburned or, if burned, should be replaced by a few brush piles or corn shocks. Furthermore, the burning over of grasslands increases the danger of erosion, because of the injury to the stands and the reduction in growth the following summer. Permanent pastures and hayfields should not be burned over, and the burning of small-grain stubble and cornstalks is not warranted, because few bugs overwinter successfully in such cover. Indiscriminate and wholesale burning is likely to do more harm than good.

USING BARRIERS

One of the oldest and best methods for controlling chinch bugs is the use, at harvesttime, of barriers along which the young bugs can be killed as they crawl from the ripening small-grain fields into corn or small grains that may still be green. At this time, except in the South, only a few bugs have reached the full-grown, or winged, stage, and most of them have to migrate on foot. By the construction and maintenance of barriers it is possible to prevent most of the damage done to corn or previously uninfested small grain by migrating bugs and by their progeny later in the summer. The saving of only 1 acre of corn more than repays the cost of 80 rods of barrier. In one instance 8 bushels of bugs were caught along ½ mile of creosote barrier in a week, and approximately the same quantity in the same barrier the next week. It was estimated that at least 60 million bugs were caught along this line in a week.

In the more southern areas the bugs may be winged before they leave the small grains, so that barriers will not control them.

When small grain is harvested with a combine, it is cut later than when harvested with a binder. Chinch bugs in the grain will leave the fields as soon as the plants do not furnish them further food, which may be before the grain has reached the cutting stage. The farmer should therefore frequently examine his ripening grain adjacent to corn. If the bugs are numerous, he should immediately set up a barrier between the small grain and cornfield.

Dirt-Ridge Creosote Barrier

Many kinds of barriers have been tried, and several have been found effective. Coal-tar creosote has been used extensively for many years, and is the best oil-type barrier material thus far tested because of its repellent and lasting qualities. Light creosote oils are easily applied, soak into soil or paper readily, and unless applied too heavily do not run down at right angles to the line and thus reduce the efficiency of the barrier. Heavy creosote oils soon become ineffective through loss of odor, hardening or drying, and becoming covered with dust.

Creosote oils are readily available in large quantities and at a low price. The grade described by Federal Specification TT–W–556A is the best of any thus far tested. Most dealers in coal-tar creosote are familiar with these specifications. However, if they are not available, a copy may be obtained from the Superintendent of Documents, Washington, D. C.

Coal-tar creosote and its fumes have a caustic effect on the skin; and this material is also poisonous when taken internally. Coating the hands and face with petrolatum or cup grease helps prevent creosote burns.

The foundation for a creosote barrier is best made by throwing up a ridge of earth with a plow, turning the dirt toward the corn. A disk cultivator or small road grader may be used instead of a plow. The side of the ridge toward the bugs should be smoothed and packed with a section of a harrow or a narrow drag, so that it is free from clods, cracks, or trash. If necessary, the upper part of the ridge should

be firmed with a shovel. A line of creosote is then applied (fig. 6) along the brow of the ridge but not quite on top of it. Therefore, when the bugs reach the creosote line they are still climbing upward, but are not yet at the top where they are likely to be blown across the line by the wind. If the creosote line is placed in the bottom of the furrow or on top of the ridge, the foremost bugs are likely to be pushed across by those crowding up behind them.

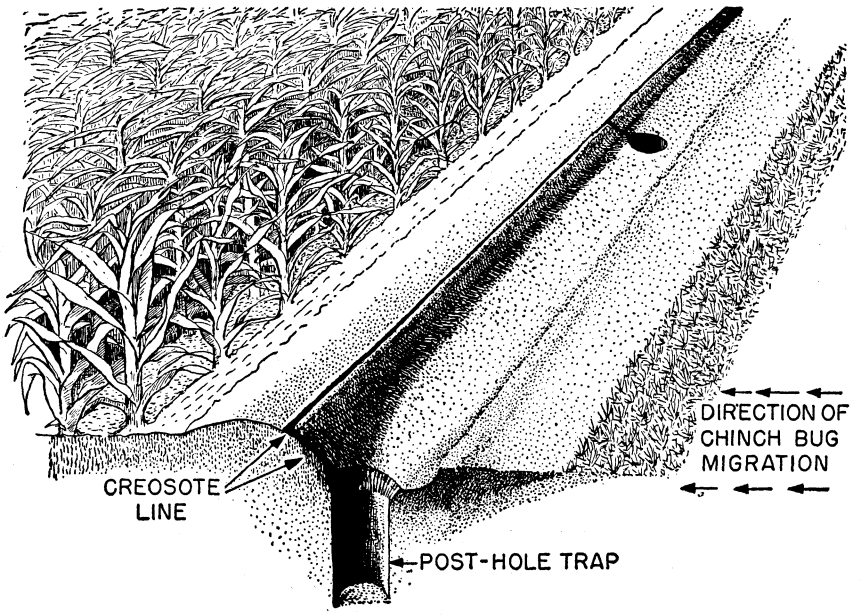

FIGURE 6.—A dirt-ridge creosote barrier is very efficient if the creosote line and post-hole traps are properly constructed and maintained.

A convenient container for use in applying the creosote is a tin or galvanized iron bucket with a hole punched in the side with an eight-penny nail. The hole should be about 1 inch from the bottom so that it is not readily clogged, and should be directly below the point where the bail is attached. The creosote is allowed to run from this hole as the bucket is carried along the barrier. Only a small quantity is necessary for one application, as a line ½ inch wide is just as effective as one 2 or 3 inches wide. Fresh creosote should be applied to the original line at least once a day for the first few days; thereafter, if care has been taken to follow the same line each time, it need be renewed only once every 2 or 3 days, unless the weather is extremely hot and dry.

When poured on the ground the oil sinks in immediately, making a brownish line on the surface and giving off a strong odor that is very repellent to the bugs. This repellent odor seems to be all that keeps them from crossing the line, and if it has been properly located very few actually do so. Light rains have the effect of freshening the creosote, as it is oily and comes to the surface when the ground is wet.

When properly applied, 50 gallons of creosote will maintain ¼ mile of barrier for about 3 weeks, which ordinarily is longer than the barrier is required.

Post holes for trapping the bugs should be dug in the furrow from 1 to 4 rods apart and from 18 to 20 inches deep. The more numerous the bugs the closer together the holes should be. They should be set part way into the ridge, and their rims should be steeply flared all around with the slope extended well up toward the creosote line. The flared rim should also be kept covered with fine dust. When the bugs traveling toward the cornfield encounter the creosote line, they begin moving along it in an attempt to find a crossing, but lose their footing in the dust and tumble into the holes. Few of them can crawl out if the rims are kept dusty. Trapping the bugs in the post holes and destroying them is fully as important as stopping their migration. This step in barrier operation is too often neglected. After it is completed, this type of barrier should not be dragged and it should be kept in good repair.

The bugs trapped in the holes should be killed every afternoon at about sundown. This may be done easily by sprinkling 1 or 2 tablespoonfuls of kerosene into each hole. The kerosene should not be ignited, but the bugs should be allowed to work it around among themselves.

Naphthalene drain oil, pine-tar oil, wood creosote, and certain kinds of gas-tar oil have also been found effective on dirt-ridge barriers. Any of these materials that have a strong odor can be used with good effect when readily available at reasonable cost.

Cresote-Treated Paper-Fence Barrier

A paper-fence barrier has been rather widely used in Iowa and Illinois. It is made by setting upright in the ground a strip of creosote-soaked paper about 4 inches wide, with half its width above the surface (fig. 7). The 2-inch fence of creosoted paper acts as a physical as well as a chemical barrier. It prevents bridging the line by straws, leaves, or dust, breaks in the barrier due to cracking of the soil in dry weather, and injury to the soil by the creosote.

Although the treated-paper fence is installed with more difficulty than the creosote line applied directly on the soil, when properly made with paper of the right kind it is less troublesome and expensive to maintain in all kinds of soil and weather. Paper fences can be installed either on the usual type of furrow and ridge already described, or on clean, level ground, as shown in figure 7. Where the barrier is likely to be submerged by the accumulation of rain water in low spots, its location on a ridge is preferable. After the paper has been prepared, two men can build 80 rods of paper fence in about 4 hours.

Single-faced corrugated paper, tarred (not asphalt-treated) felt paper of the 14- or 15-pound grade, red-rosin building paper of the 30-pound grade or heavier, and heavy chip board or chip strawboard from 20 to 40 points thick have been used successfully. The choice of paper is usually determined by availability and cost. The rolls as purchased are cut with a crosscut saw into narrower rolls about 4 inches wide. With some papers it is necessary to oil the saw blade or clean it occasionally with kerosene. After being cut, the rolls are soaked

for at least 12 hours in a container with enough creosote to keep them covered, and then allowed to drain for an hour or more before the fence is built.

The manner of erecting the treated-paper fence depends upon the tools available and the character of the soil. A handy tool for use in unrolling and installing the paper strips may be made by fitting a broom handle into a hole in the side of a piece of two-by-four about a foot long, so as to form a T-shaped carrier, and slipping the roll of paper down over the handle until it rests on the crosspiece at the bottom. After a ridge or a smooth path free from litter has been prepared, a wheel hoe or a garden cultivator with a small-plow attachment, or a corn cultivator with all but one shovel removed, may be

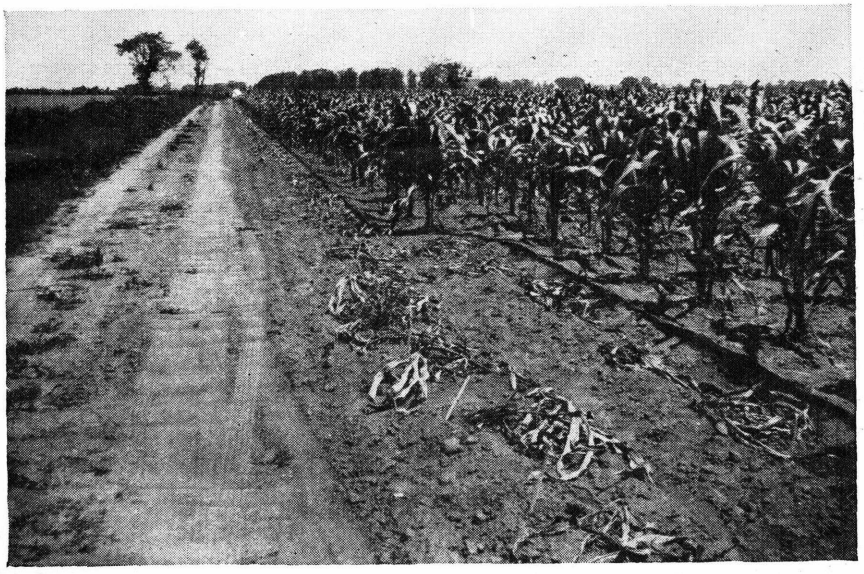

FIGURE 7.—A creosote-treated paper-fence barrier stopped a chinch bug migration from small grain to corn. The corn plants on the side of the barrier nearest the wheat field were killed by the bugs.

used to open a small furrow to receive the paper. When the ground is very hard, it may be necessary to use a turnplow. In this case the paper is unrolled against the straight, or land, side of the furrow and the dirt is packed against it. In any event it is important that the dirt be packed firmly and evenly to the same level on both sides of the paper; otherwise rainwater or caving soil may cause greater pressure on the higher side, resulting in a collapse of the fence.

A paper-laying machine devised at the Iowa Agricultural Experiment Station has been extensively used by the farmers in that State and in Illinois.

Post holes for trapping and killing the bugs are just as important with paper fences as with the ground-line creosote barriers. They should be dug every 1 to 4 rods on the side of the paper toward the small grain and 4 to 6 inches away from it, with their edges sloped out almost to the paper and then dusted.

If the paper fence has been properly treated, it should repel the bugs for 2 or 3 days. Then it will have to be freshened by applying more creosote close to the top edge. A bucket with a hole near the bottom, as described on page 13, can be used for this purpose. The application can be made much more easily if a copper tube is soldered into the hole so as to extend downward for 12 or 15 inches, and its end curved sideways to direct the stream against the paper. A horizontal prong is soldered to the tube near the lower end to slide along the top edge of the paper and act as a guide (fig. 8). From 2 to 3 gallons of

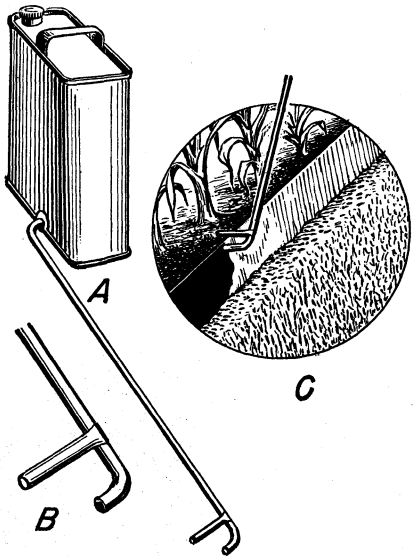

FIGURE 8.—Renewing creosote on paper fence: *A*, Receptacle with a copper tube; *B*, guide prong soldered near end of tube; *C*, applying creosote to paper fence. (Iowa Agricultural Experiment Station.)

creosote is needed to treat ¼ mile of 2-inch paper fence. After it is well soaked, the paper barrier will not need retreatment so frequently as a creosote line on the ground.

The treated-paper barrier costs about the same as the dirt-ridge ground-line barrier. About 30 gallons of creosote is sufficient to maintain ¼ mile of paper-fence barrier for the season. This is about two-thirds the quantity required for the ground-line type.

Poison-Dust Barrier

Recently a poison-dust barrier (fig. 9) has been developed which is very effective. A dust containing either a dinitro compound [5] or DDT with pyrophyllite is recommended.

A 4-percent dinitro dust has proved to be effective against migrating chinch bugs. If migrating bugs are very abundant, it is advisable to

[5] Dinitro-orthocresol, dinitro-orthocyclohexylphenol, and dinitro-orthoisopropylphenol are about equally effective.

use 2 pounds of the dust per rod of barrier. About 5 percent of mineral oil (100 seconds Saybolt viscosity at 100° F.) is sometimes added to give the dust stability and prevent it from being blown away. The bugs are not repelled by the dust, but upon coming in contact with it are poisoned and crawl under clods or other debris nearby, where they die within a few hours. After crossing the barrier, they seldom crawl onto the plants and feed.

The dinitro dusts are injurious to plant life and therefore should not be applied directly to crops.

A 10-percent DDT dust also makes an effective barrier for migrating bugs, but acts more slowly. The bugs may live for several days after having come in contact with this dust, but they feed very little during this interval.

It is not necessary to construct a dirt ridge or paper fence, or to dig post holes, when a poison-dust barrier is used. The dust is applied in a continuous band 1 to 2 inches wide in a shallow depression or track made by dragging a log weighing about 15 pounds, or driving an automobile or small truck along the field. Before the track is made, the soil surface must be freed from all trash and other debris, so that the bottom will be even and smooth.

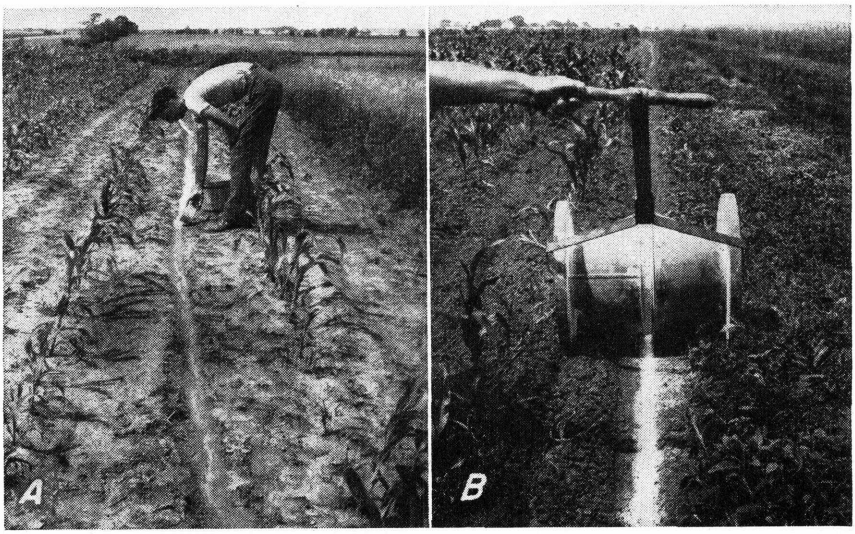

FIGURE 9.—*A*, Laying a poison-dust line for a barrier against migrating chinch bugs; *B*, a home-made applicator for laying a poison-dust line.

The poison dust may be applied from a tin can (fig. 9, *A*) or with an applicator (fig. 9, *B*). The applicator is made from two hollow cones of galvanized iron with one end about 15 inches and the other about 10 inches in diameter. Wooden disks are fitted and nailed into the smaller ends, and these disks are then nailed to much larger disks which serve as wheels. The larger ends of the cones are soldered to a galvanized-iron band about 1½ inches wide perforated with five rows of 1/16-inch holes 3/8 inch apart. An opening 3 inches in diameter is

made through the disks at one end of the container for introducing the dust, and is provided with a plug or sliding cover. The container is also supplied with an axle to which is attached an old lawn-mower handle. The container has no agitator, but when rolled along the bottom of the depression or wheeltrack, the dust runs to the center and through the small openings onto the ground. The rate of flow depends on the texture of the material. A dust without oil spreads so readily that two rows of perforations must be closed with tape to lay this material at the proper rate. A dust with oil spreads more slowly, and all perforations are left open.

After a dust line is made, it should be patrolled every day during the migration period to remove leaves and other debris that may have been blown onto it. Breaks in the line caused by wind, rain, or water, or cracks in the soil should be repaired. Lines that have been destroyed by heavy rain should be completely renewed.

Although the material for a poison-dust barrier usually costs more than that for a creosote barrier, the labor required in the construction and maintenance is usually less, so that the total cost is no greater. During periods of light or no rainfall 1 pound of the dust per rod is sufficient to maintain a barrier while the bugs are migrating. During rainy seasons more dust would be required. The ease with which the dusts may be handled, transported, and applied and the fact that they kill the bugs upon contact, make poison dusts very desirable for the construction of barriers against migrating chinch bugs.

When chinch bugs are discovered in a cornfield a barrier is constructed, and then a 10-percent DDT dust is applied to kill the bugs feeding on the corn plants. About 50 pounds per acre is necessary for satisfactory control.

CAUTION.—Do not inhale these dusts; protect the hands while working with them to prevent irritation of the skin. After handling the material bathe thoroughly and wash contaminated clothing with soap and water.

Coal-Tar or Gas-Tar Barrier

Another type of barrier is made by pouring a narrow line of coal tar or gas tar on a path made by smoothing and packing the soil firmly along the margin of the field. Chinch bugs are repelled by the odor of the tar, and while fresh it also acts as a physical barrier because of its stickiness. Where the proper grade of tar can be obtained cheaply and readily, its use is highly practical. However, a tar barrier has to be renewed oftener than one made of creosote. Tars from which the creosote and cresylic acids have not been distilled should be procured. Tars that are byproducts of the manufacture of water gas have little value against chinch bugs. Post holes properly dug and maintained are also essential to the effective operation of tar barriers.

Burning Along the Barrier not Recommended

It is possible to kill nearly all the chinch bugs along a creosote or tar barrier by flaming with a large blowtorch, but this method is

not recommended, since practically the same result can be attained at much less expense by the use of the post-hole traps.

Bugs congregating on the outer rows of corn may be killed by flaming them with a torch, but usually the plants will also be killed. A better procedure is to disk the ruined portion of the field and plant it to soybeans.

Dust Barriers

The oldest type of barrier is a dusty furrow or strip around the field to be protected. The furrow barrier is the best and is generally made by plowing a furrow, throwing the dirt both ways, and then dragging a log or a trough made of planks back and forth in this furrow until the sides and bottom have been worked down to a fine dust. Sometimes two parallel furrows are plowed, and a double drag is constructed with a raised connection to span the intervening ridge. Both furrows may thus be dragged with little more labor than would be required for a single furrow. Effective dust barriers have also been maintained by repeatedly dragging a harrow back and forth over a strip of ground across the field in front of the bugs, thus working up a deep, fine dust mulch in which the bugs are buried as they crawl into it. No post holes are used with dust barriers.

On certain types of soil, and during dry weather, dust barriers are very satisfactory. While dry they remain impassable to chinch bugs if frequently dragged, and most of the bugs that fall into them are killed by the drag, the heat of the sun, or the dust itself. Of course, dust barriers are of no value during periods of rain. A heavy shower may ruin the dust mulch, so that the bugs are able to cross in sufficient numbers to destroy 1 or 2 acres of corn before a fresh dust can be worked up. In some soils it is impossible to make a dust so fine that the chinch bugs cannot crawl through it. Although the dust barrier does not require any costly equipment or material, constant labor is necessary to maintain it, and the expense is often greater than for a more dependable and efficient creosote, tar, or poison-dust barrier.

Barriers of Little or no Value

A number of suggested chinch bug barriers have proved to be practically worthless. Barriers made by planting narrow strips of some legume between the small grain and the corn are of little or no value. Cowpeas or soybeans are the legumes most frequently used in this way, but the bugs crawl through them about as readily as they would pass over the bare ground. It has also been suggested that the bugs would feed upon freshly cut cornstalks laid in a continuous line along the margin of the grainfield, and would be poisoned by this material as it soured. Numerous tests with this type of barrier have shown that it also is worthless. Occasionally cast-off skins of the bugs may be found scattered through the cornstalks, and they are often mistaken for dead bugs. Close examination, however, has failed to show that any chinch bugs are killed by this kind of a barrier.

SPRAYING AND DUSTING WITH INSECTICIDES

Sprays or dusts have not yet been found practical for reducing chinch bug infestations in small grains. However, they are recommended for use on small plantings of valuable seed corn or parts of cornfields that have been invaded by bugs from adjacent small-grain

FIGURE 10.—Spraying infested corn plants.

fields before the farmer has been able to construct a barrier. After a barrier has been made, the infestation within the cornfield may be controlled with a dust or spray. Since chinch bugs do not eat plant tissue, they cannot be killed by poison merely sprayed or dusted on the plants but must be hit by the insecticide.

One of the best dusts yet found is one containing 4 percent of sabadilla powder, when used at the rate of 50 pounds to the acre. It

may be applied with a hand duster, but preferably with a knapsack or rotary duster. All bugs receiving a coating of the dust die within an hour.

Among the sprays found effective are those containing nicotine plus soap and a nicotine or rotenone mineral-oil emulsion.

The nicotine-soap spray is prepared by dissolving ½ ounce of 40-percent nicotine sulfate and 1 ounce of soap in 1 gallon of water.

The nicotine or rotenone mineral-oil emulsion spray is made as follows: Dissolve 1 pound of potash (yellow) laundry soap in ½ gallon of hot soft water, add slowly 1 gallon of highly refined white mineral oil, and beat until emulsification is complete. To 1 part by volume of this stock solution add 30 parts of water and ⅛ ounce (approximately 1 teaspoonful) of nicotine sulfate or a derris extract containing 5 percent of rotenone.

These sprays may be applied with any hand sprayer at the rate of 70 gallons per acre (fig. 10). All the bugs receiving a good wetting will be killed.

Oil emulsions made from some commercially emulsifiable concentrates are as effective as a home-made emulsion. These concentrates are usually much higher in price, but may be preferred as a matter of convenience. They should be diluted with water in accordance with directions given on the containers.

In Oklahoma satisfactory control of adult chinch bugs in corn has been obtained with toxaphene sprays and dusts applied at the rate of 1½ pounds of toxaphene per acre.

U. S. GOVERNMENT PRINTING OFFICE: 1951

For sale by the Superintendent of Documents, U. S. Government Printing Office
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